

MODIS Cloud Property Validation

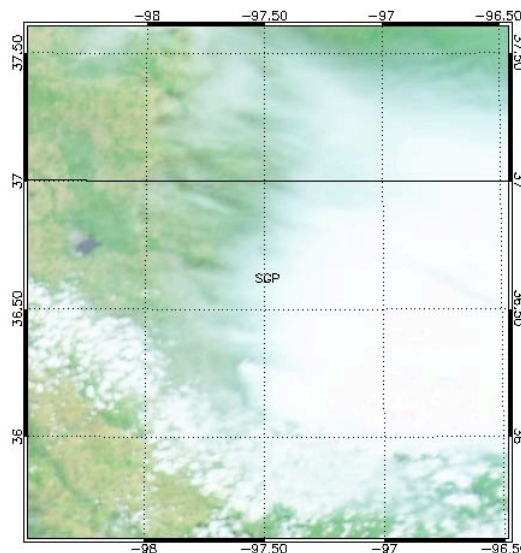


An Application of an Online Relational Database Using ARM and MODIS Data

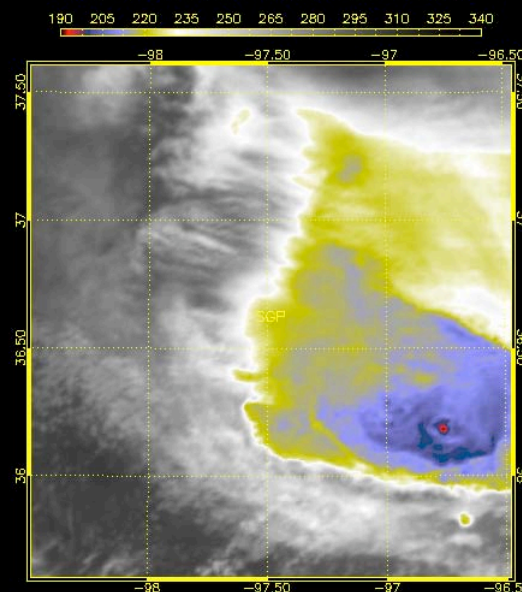
Jay Mace and Chris Galli

Motivation: Exploit long-term measurements at ground sites to create meaningful validation statistics of MODIS Cloud properties.

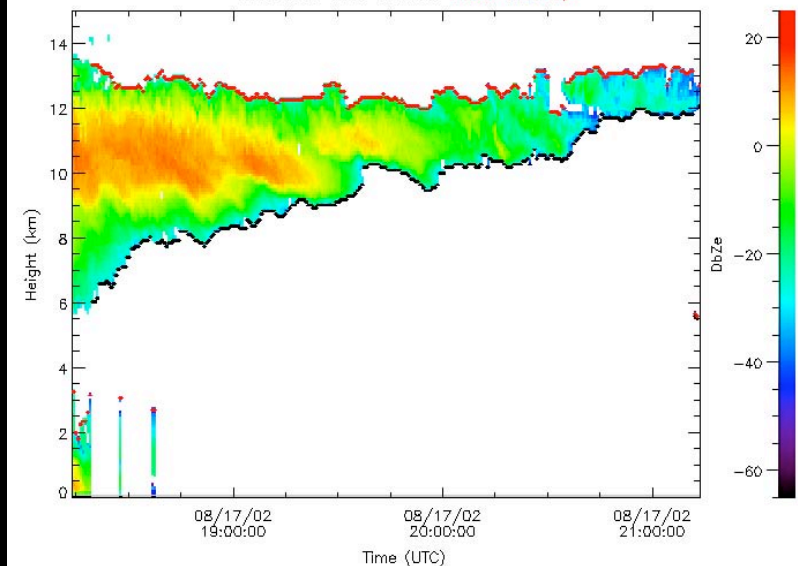
Level 1B Radiances
SGP, 17 Aug 2002, 1940 UTC
MYD021KM.sgp.subset.20020817.1940.004.cdf.gz

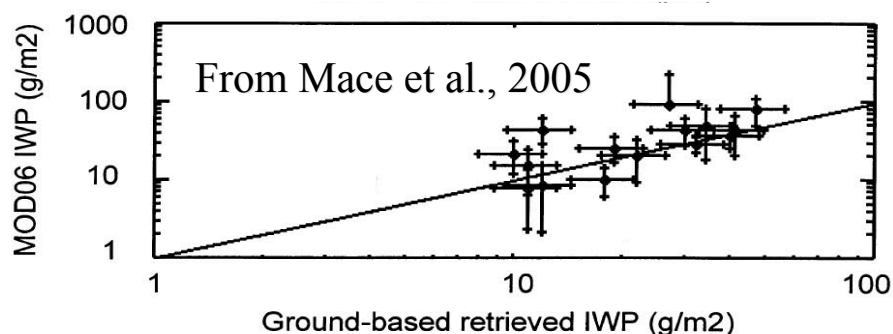


MYD021KM, 10.780 – 11.280 μm
SGP, 17 Aug 2002, 1940 UTC
MYD021KM.sgp.subset.20020817.1940.004.cdf.gz



SGP Merged Moments, 17 August 2002
sgpmmcrMergedMomentsC1.a1
cloud base best estimate radar first top





With 2 MODIS instruments, 5 ARM sites, and multiple years, many thousands of overpasses can be evaluated!

Goals:

- 1) Move beyond case studies
- 2) Expand beyond selected cloud types
- 3) Develop an interface for easy exploration of the data

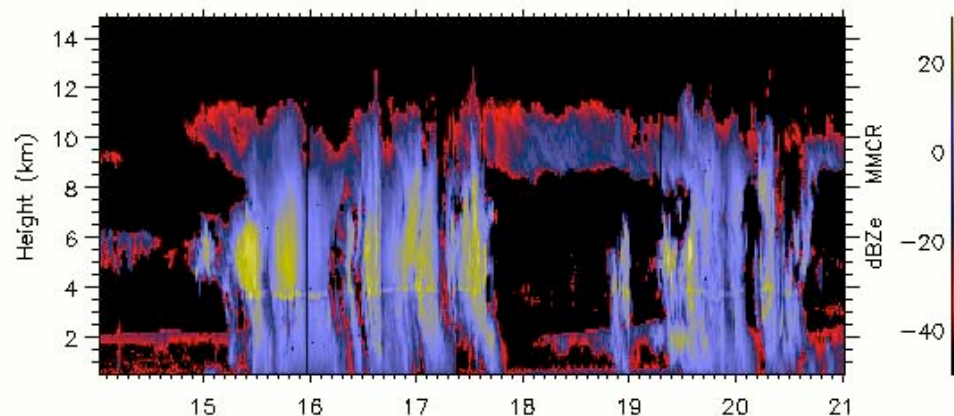
Challenges: 1) Convert the ARM data into something useful
2) Data Logistics and Interface Development



ARM Data Processing

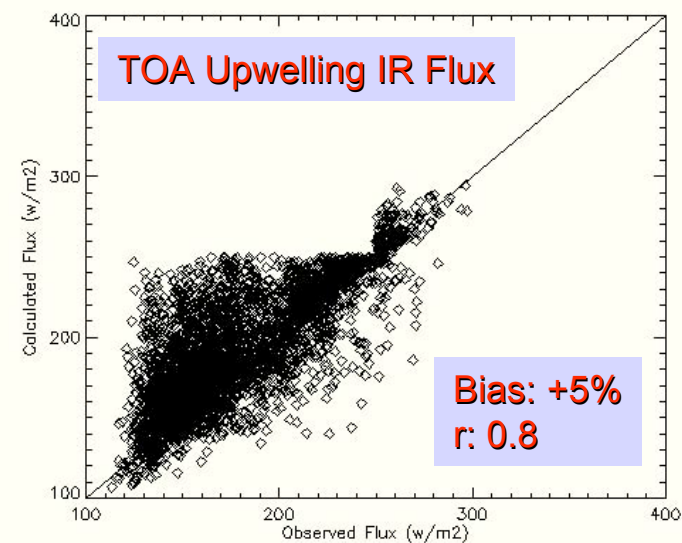
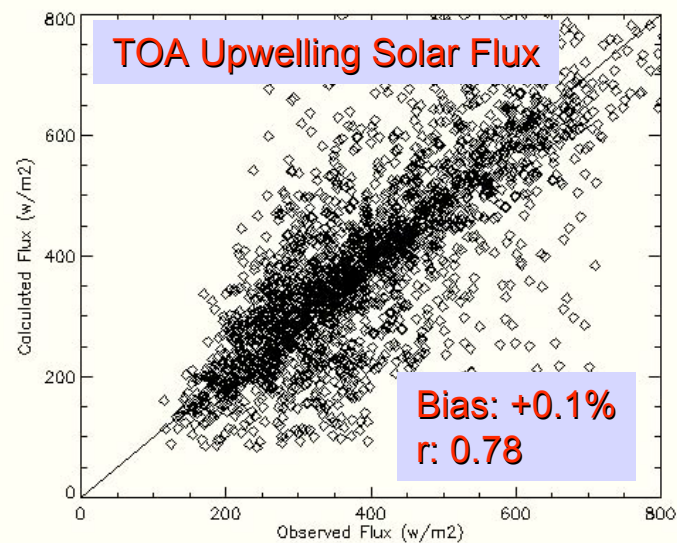
We have developed an algorithm suite to reduce the ARM data from Level 1 to a temporally continuous and validated physical description of the atmospheric profile:

- Cloud occurrence
- Cloud microphysical and radiative properties of liquid, ice, and mixed phase clouds
- Radiative Flux Profiles

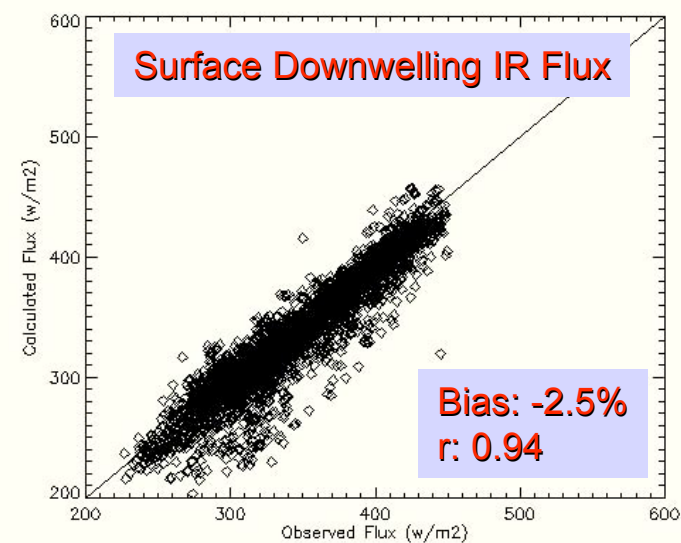
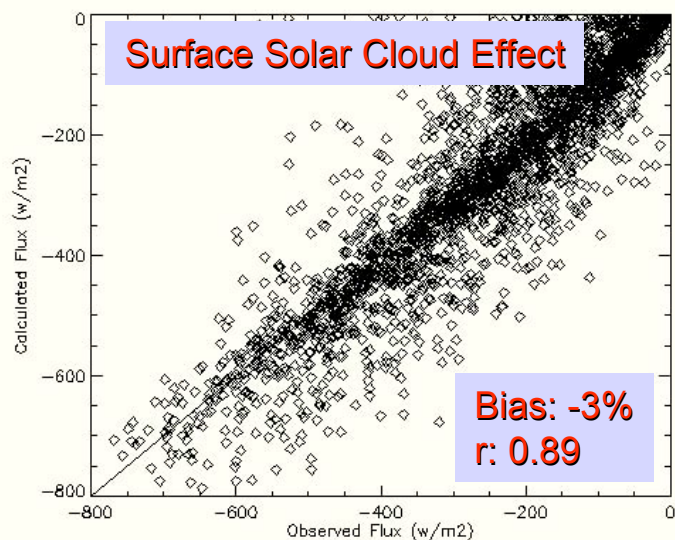


MACE ET AL.: CLOUD FORCING AT THE ARM CRF, 1

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 111, D11S90, doi:10.1029/2005JD005921, 2006



Validation



ARM and MODIS data are staged within a MYSQL relational database that is accessed over the internet using a PEARL driven front end

Presently we have Aqua MODIS Collection 5 and ARM data through 2004 – 530 unique events.

EOS Validation Interface – Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://www.met.utah.edu/cgi-bin/mace/cgalli/mysql/eos_avg_query.pl

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MODIS CLOUD PROPERTY VALIDATION

DATA SELECTION

Select Date Range:

2000 01 1 (start)
2006 10 27 (end)

Datastreams to compare:

MYD06 v5 as DS 1
average.5min.ciret4 as DS 2

Property:

optical depth

☒ Matching times only.

Site:

sgp

Submit

DATA FILTERS

Selected Datastream Value Filters:

		<		x
		<		x
		<		x
		<		x
		<		x
		<		x

Distribution Filters:

Where the standard deviation for: (data/property)
is within % of the mean for each individual event/overpass.



Avg. MODIS box over ARM: 32 Km (from center)
Avg. ARM time Spanning: 3600 Seconds
Where overpass angle: < 90


PLOT OPTIONS

☐ Use log10 scale for scatter plots and statistics
☐ Show SQL query.
☐ Show data table with EOS links.

Number of histogram bins: 10

[Database Overview](#)
[Development Notes](#)







DATA SELECTION

Select Date Range:

2000 01 1 (start)

2006 10 27 (end)

Datastreams to compare:

MYD06 v5 as DS 1

average.5min.ciret4 as DS 2

Property:

optical depth

☒ Matching times only.

Site:

sgp

Submit

DATA FILTERS

Selected Datastream Value Filters:

DS 1	optical depth	<	100.
DS 2	optical depth	>	1.
Both DS	top clouddrop pressure	<	80000.
		<	
		<	
		<	

Distribution Filters:

Where the standard deviation for:

Both DS top clouddrop temp (data/property)

is within 20 % of the mean for each individual event/overpass.

Avg. MODIS box over ARM: 32 Km (from center)

Avg. ARM time Spanning: 3600 Seconds

Where overpass angle: < 30

PLOT OPTIONS

☒ Use log10 scale for scatter plots and statistics

☐ Show SQL query.

☒ Show data table with EOS links.

Number of histogram bins: 10

[Database Overview](#)

[Development Notes](#)



EOS Validation Interface - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://www.met.utah.edu/cgi-bin/mace/cgall/mysql/eos_avg_query.pl

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MODIS Cloud Property Validation

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optical depth

☒ Matching times only.

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sgp

Submit

DATA FILTERS

Selected Datastream Value Filters:

DS 1	optical depth	<	100.	x
DS 2	optical depth	>	1.	x
		<		x
		<		x
		<		x
		<		x

Distribution Filters:

Where the standard deviation for:

Both DS top cloudtop temp (data/property)

Is within 200 % of the mean for each individual event/overpass.

Avg. MODIS box over ARM: 32 Km (from center)

Avg. ARM time Spanning: 3600 Seconds

Where overpass angle: < 90

PLOT OPTIONS

☒ Use log10 scale for scatter plots and statistics

☐ Show SQL query.

☒ Show data table with EOS links.

Number of histogram bins: 10

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[Development Notes](#)

Total ARM cloudiness: 86%

Mean of MYD06 v5 (DS1):	1.04451039662287
Mean of average.5min.ciret4 (DS2):	1.23329451578247
Mean difference of DS1 to DS2 (bias):	-0.188784119159603
Mean difference sdev of DS1 to DS2 (bias sdev):	0.449662461812286
Linear slope:	0.991522771912514
Linear intercept:	0.197638672031526
Correlation:	0.74935480957350245825
RMS:	0.480169454696018
RMS fraction:	0.553177668830923
Standard deviation about the linear fit:	0.188834105788111

Done

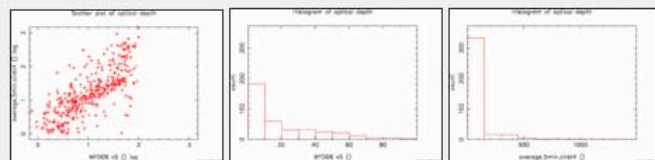
Fri Oct 27 13:37

College of Mines & Ear [Terminal] EOS Validation Interface

SUMMARY STATISTICS FOR OPTICAL DEPTH

Period Starting: 20020704 19:20:34 Ending: 20041227 19:00:42

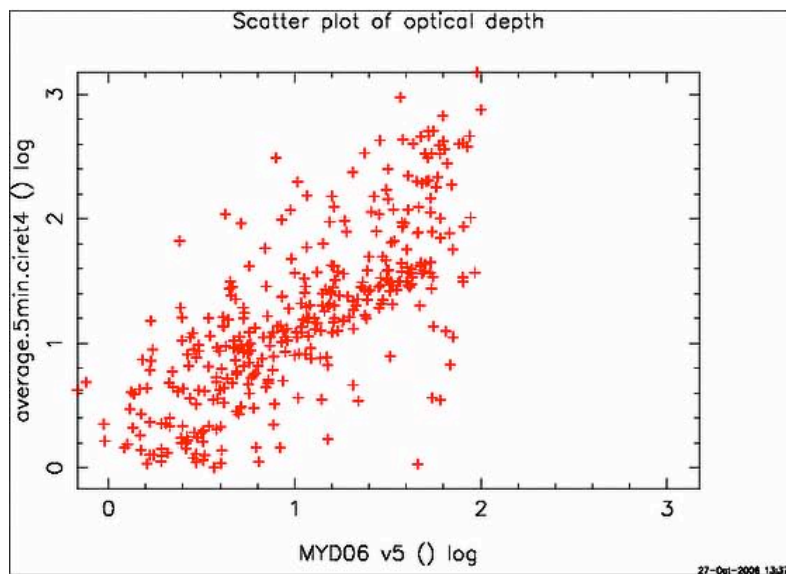
datastream	min value	max value	sum	mean	sdev	count
MYD06 v5	0.6810	99.985	7621.516	20.433	21.463	373
average.5min.ciret4	1.0075	1495.846	22912.574	61.428	138.001	373



Download this data:

[Text-Query Conditions and Result Set](#)

[Zip File-Query Conditions and Result Set with Images](#)



Histogram of optical depth

Done

EOS Validation Interface – Mozilla Firefox

File Edit View Go Bookmarks Tools Help

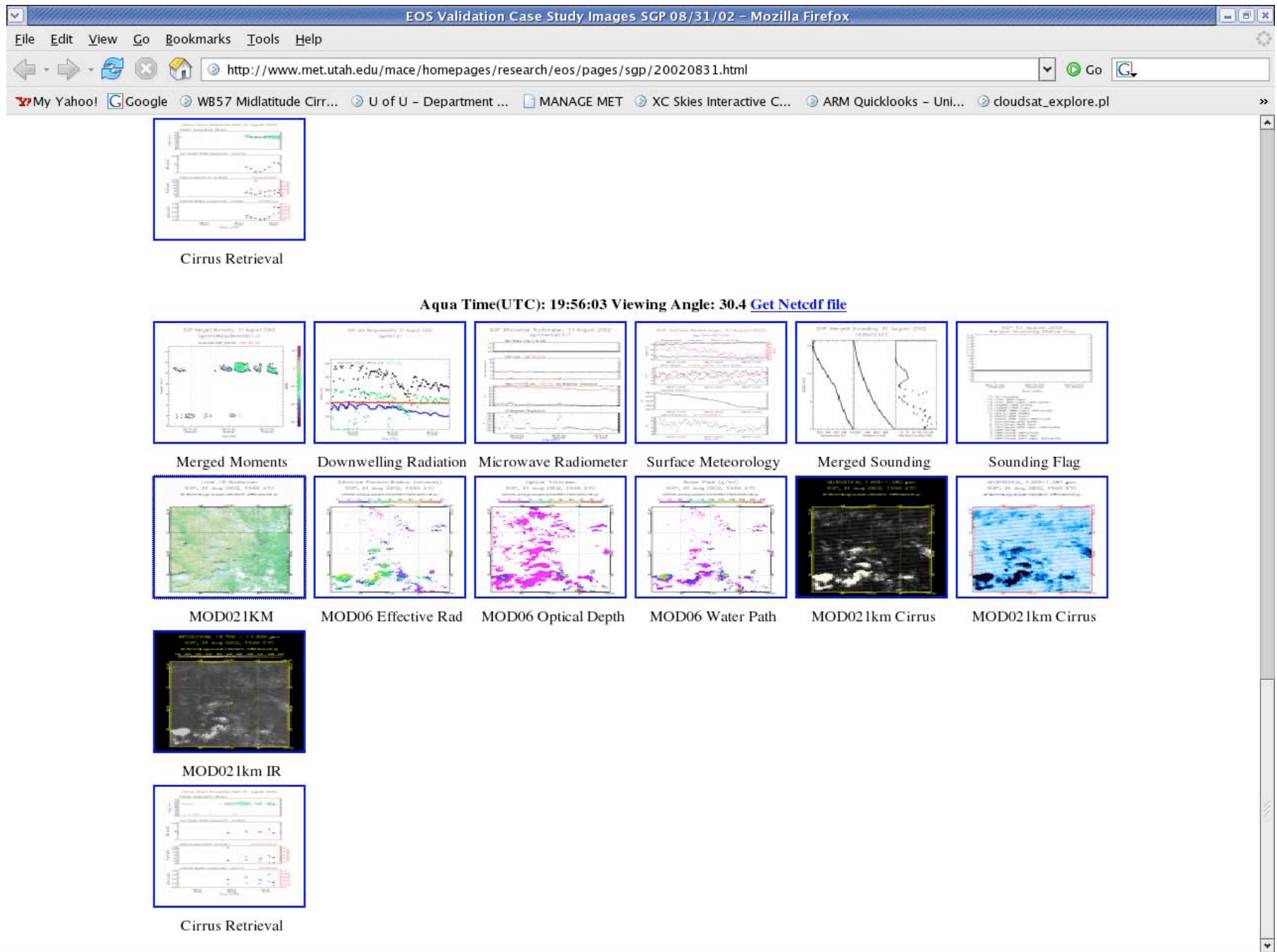
[http://www.met.utah.edu/cgi-bin/mace/cgalli/mysql/eos_avg_query.pl](#)
Go

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Google
WB57 Midlatitude Curr...
U of U – Department ...
MANAGE MET
XC Skies Interactive C...
ARM Quicklooks – Uni...
cloudsat_explore.pl

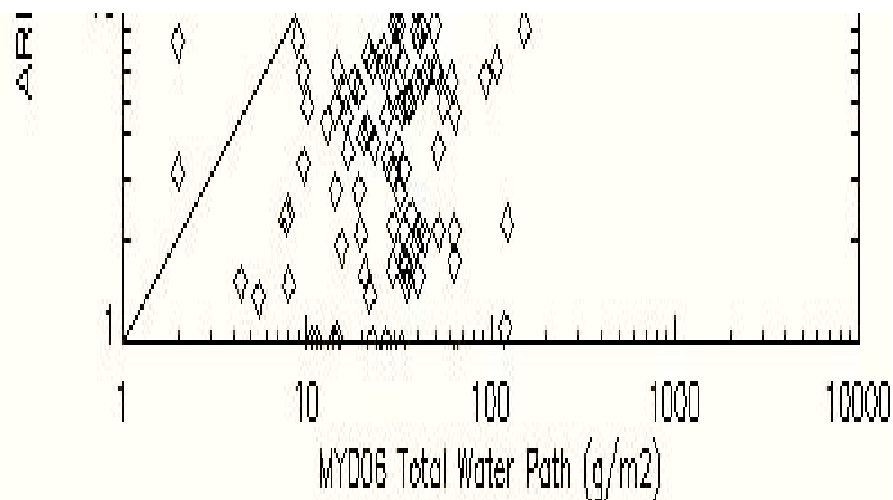
(1027364894)	average5minclret4	15.18314	9.78567	5.39747	24.96881	2	16		
20020723 19:50:47 (1027453847)	aqua_v5	5.724	6.2	0.01	46.8	2097	79	EOS Quicklooks Sat Plot	
	average5minclret4	3.96488	5.21422	0.01054	14.56312	8	68		
20020729 19:14:16 (1027970056)	aqua_v5	2.228	1.281	0.03	5.66	622	20	EOS Quicklooks Sat Plot	
	average5minclret4	4.44991	4.00243	0.29709	16.81187	19	84		
20020808 19:50:29 (1028836229)	aqua_v5	4.182	5.92	0.01	82.78	1751	35	EOS Quicklooks Sat Plot	
	average5minclret4	3.33188	0.37510	2.95678	3.70698	2	19		
20020809 18:55:40 (1028919340)	aqua_v5	2.996	1.936	0.12	13.16	708	89	EOS Quicklooks Sat Plot	
	average5minclret4	1.76533	0.00000	1.76533	1.76533	1	15		
20020811 20:21:03 (1029097263)	aqua_v5	2.971	3.551	0.02	40.56	730	65	EOS Quicklooks Sat Plot	
	average5minclret4	7.65233	0.00000	7.65233	7.65233	1	14		
20020813 20:08:40 (1029269320)	aqua_v5	47.498	28.879	9.81	100	1181	100	EOS Quicklooks Sat Plot	
	average5minclret4	457.16143	286.63997	146.55109	1192.11084	23	99		
20020816 19:01:28 (1029524488)	aqua_v5	4.867	1.791	1.15	8.9	869	97	EOS Quicklooks Sat Plot	
	average5minclret4	5.64725	5.56214	0.85496	17.99900	24	100		
20020817 19:44:01 (1029613441)	aqua_v5	13.186	14.376	0.04	100	2356	94	EOS Quicklooks Sat Plot	
	average5minclret4	37.31867	39.97276	2.11792	150.29274	24	100		
	date	datastream	mean*	sdev	min val	max val	count	% cloudy	link
20020820 20:14:27 (1029874467)	aqua_v5	3.462	3.663	0.14	26.88	979	87	EOS Quicklooks Sat Plot	
	average5minclret4	2.17538	2.43515	0.02945	7.01901	24	100		
20020824 19:49:53 (1030218593)	aqua_v5	15.657	18.99	0.01	100	730	31	EOS Quicklooks Sat Plot	
	average5minclret4	24.87627	37.57981	0.02416	89.67722	4	35		
20020831 19:56:03 (1030823763)	aqua_v5	1.493	1.515	0.01	12.41	624	14	EOS Quicklooks Sat Plot	
	average5minclret4	1.39239	1.21376	0.06105	3.13890	10	60		
20020913 19:25:10 (1031945110)	aqua_v5	62.294	36.557	0.09	100	1851	93	EOS Quicklooks Sat Plot	
	average5minclret4	667.43934	524.48969	20.26261	1618.19604	21	95		
20020914 20:07:52 (1032034072)	aqua_v5	10.927	16.172	0.01	100	889	63	EOS Quicklooks Sat Plot	
	average5minclret4	12.21774	9.84127	0.11054	29.35194	14	72		
20020916 19:55:28 (1032206128)	aqua_v5	3.049	2.487	0.11	24.18	640	20	EOS Quicklooks Sat Plot	
	average5minclret4	9.66433	10.82961	0.70803	39.49352	24	100		
20020919 18:48:46 (1032461326)	aqua_v5	36.031	25.185	4.93	100	563	100	EOS Quicklooks Sat Plot	
	average5minclret4	30.91742	15.90491	12.39510	69.59904	24	99		
20020919 20:26:24 (1032467184)	aqua_v5	42.479	23.203	5.43	100	584	99	EOS Quicklooks Sat Plot	
	average5minclret4	39.44668	14.22763	24.70739	85.60583	24	100		

[http://www.met.utah.edu/mace/cgalli/tmp/query_1161977863.53986.txt.zip](#)

Fri Oct 27 13:39
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[Terminal]
EOS Validation Interface



Initial Comparison Results All Clouds, No Conditions



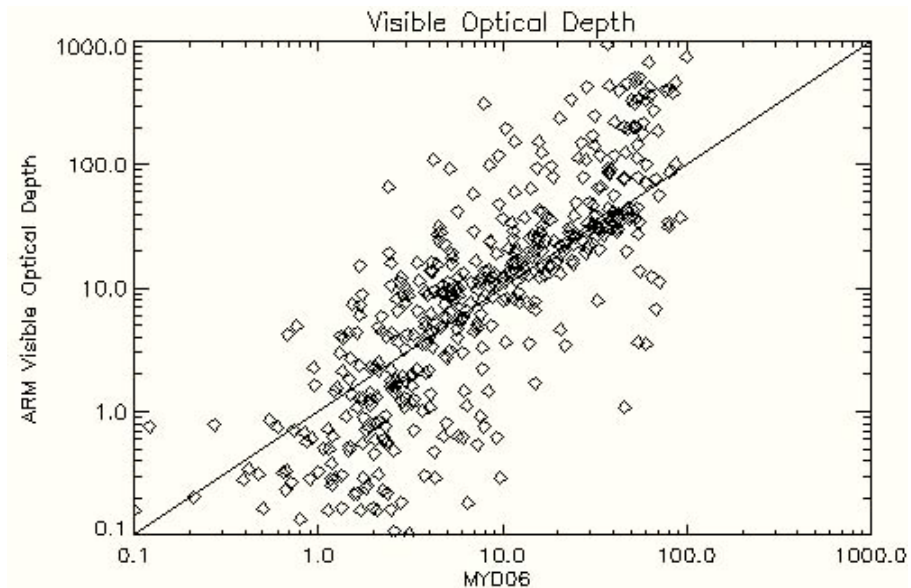
Statistics (Log10)

MODIS=1.89

ARM=1.65

$r=0.82$

Norm Dev=0.41



Statistics (Log10)

MODIS=0.82

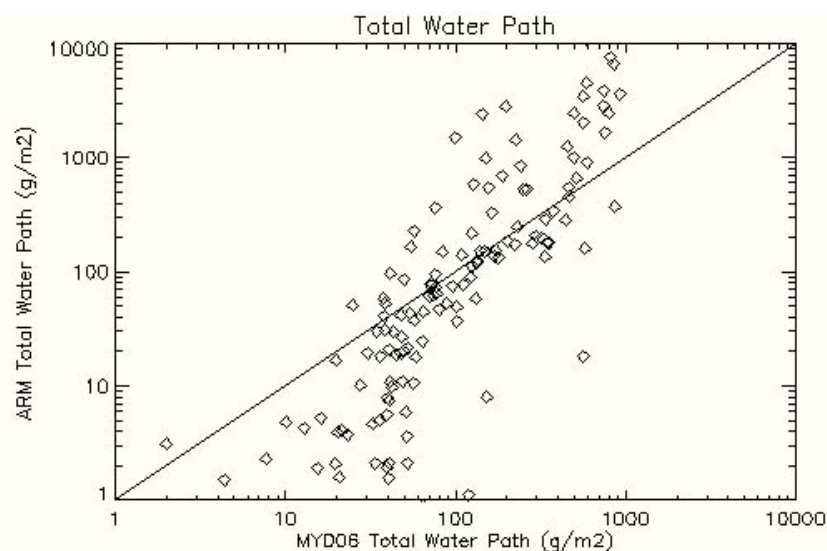
ARM=0.74

$r=0.80$

Norm Dev=0.26

Initial Comparison Results

All Clouds, View Zenith < 30 degrees



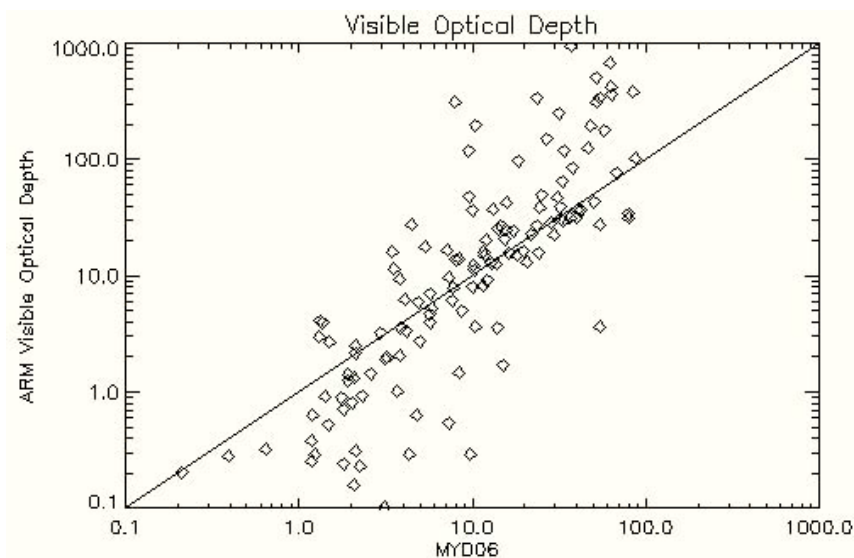
Statistics (Log10)

MODIS=1.94

ARM=1.69

$r=0.82$

Norm Dev=0.47



Statistics (Log10)

MODIS=0.92

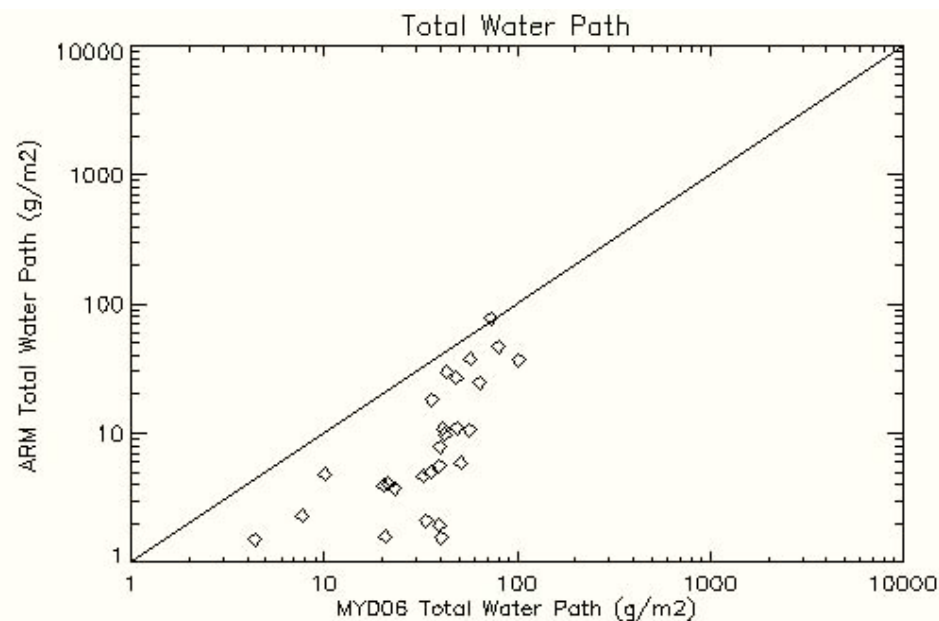
ARM=0.78

$r=0.79$

Norm Dev=0.37

Initial Comparison Results

Cirrus, View Zenith < 30 degrees



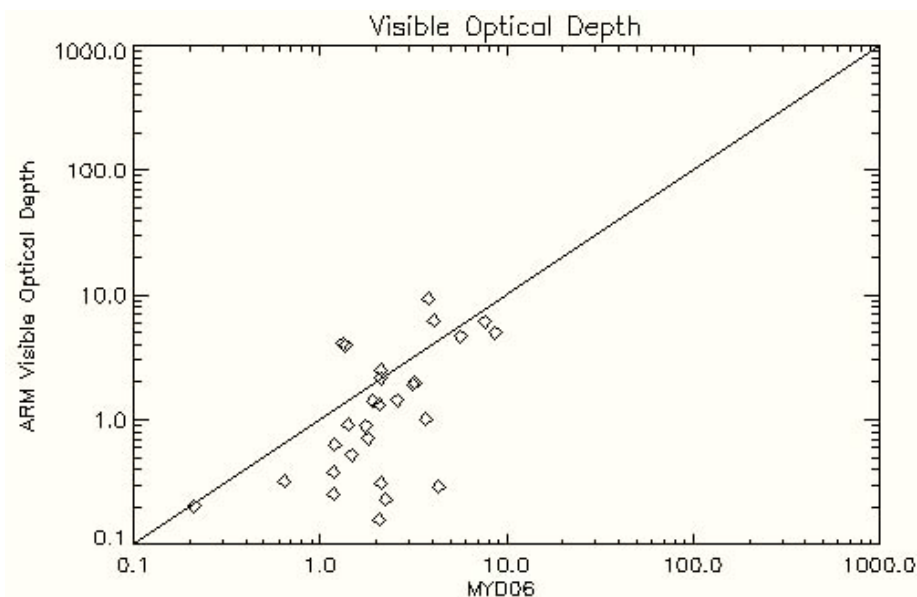
Statistics

MODIS=38

ARM=12

$r=0.73$

Norm Dev=0.27



Statistics

MODIS=2.5

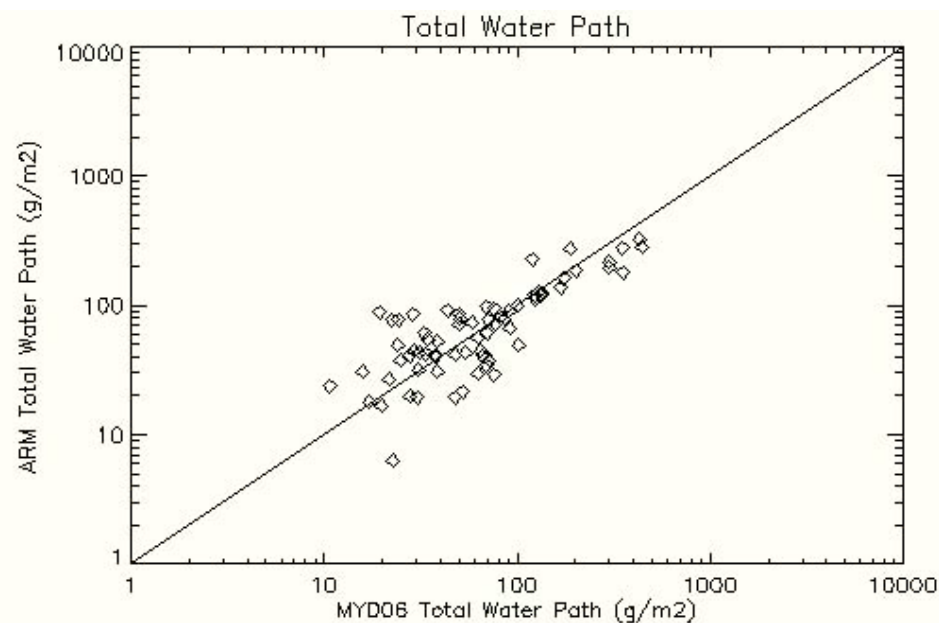
ARM=1.7

$r=0.63$

Norm Dev=0.87

Initial Comparison Results

Stratus, View Zenith < 30 degrees



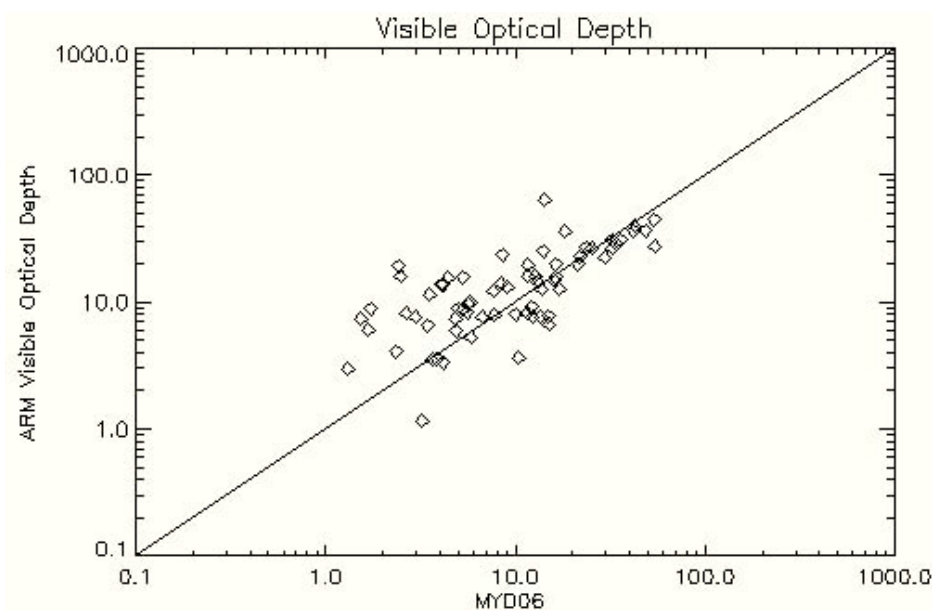
Statistics

MODIS=107

ARM=84

$r=0.93$

Norm Dev=0.49



Statistics

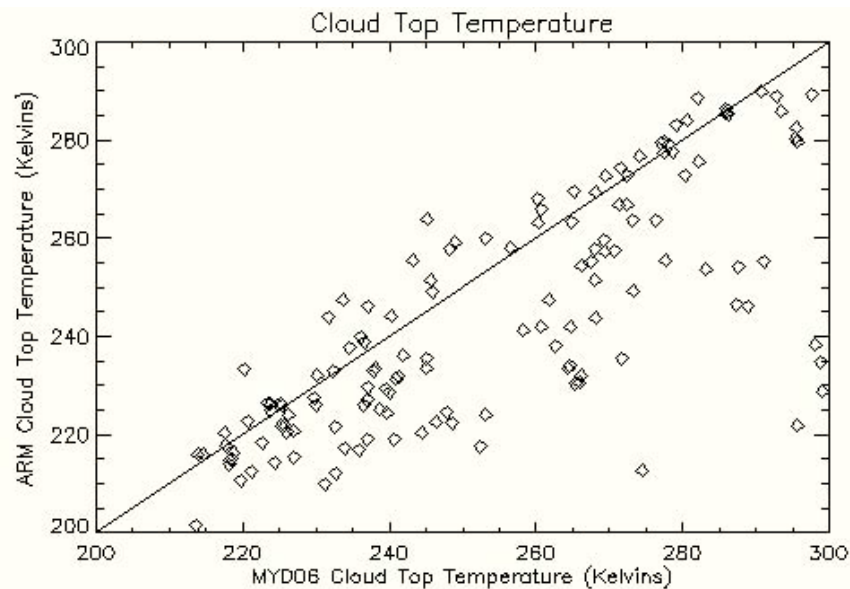
MODIS=17

ARM=16

$r=0.86$

Norm Dev=0.5

Initial Comparison Results Cloud Top Pressure and Temperature



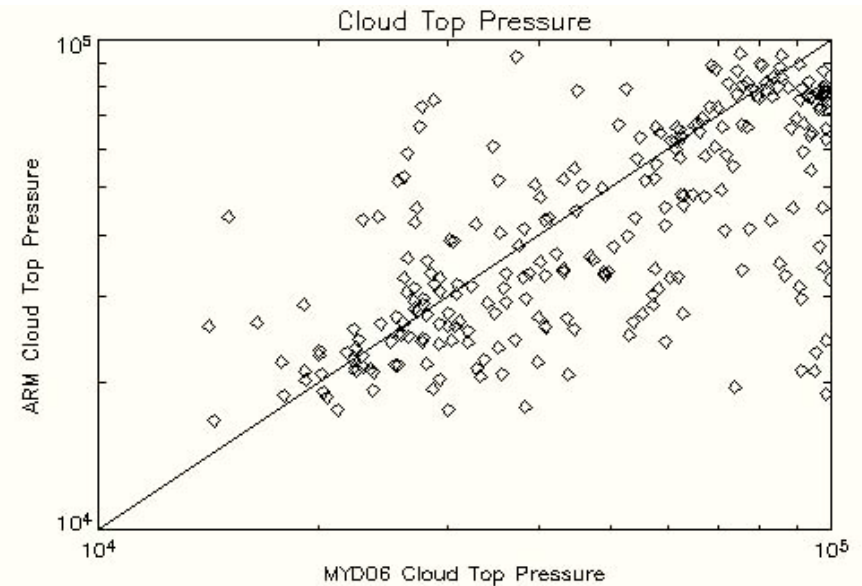
Statistics

MODIS=255

ARM=244

$r=0.73$

Norm Dev=0.14



Statistics

MODIS=540

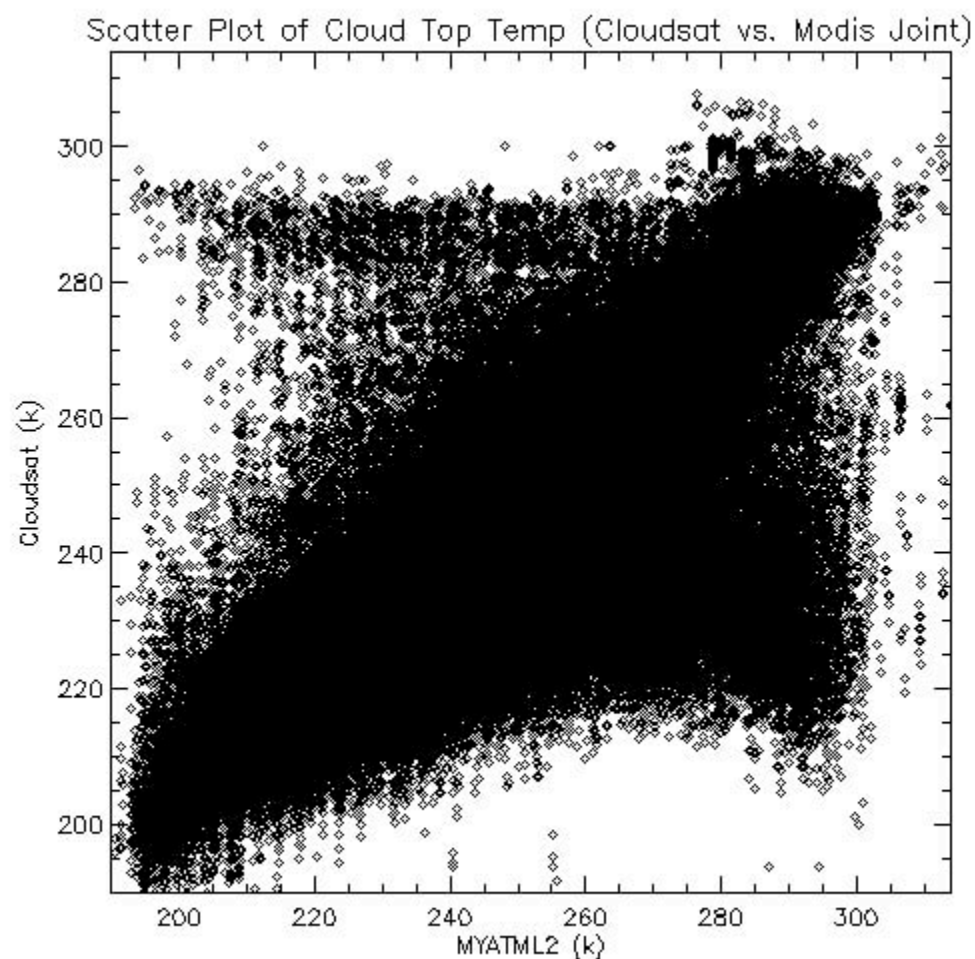
ARM=459

$r=0.61$

Norm Dev=143



Some thoughts on how Cloudsat and Calipso changes the MODIS validation strategy:





Summary:

Developing a validation/comparison interface that will allow for development of viable error statistics of MODIS cloud properties

Present implementation is for Aqua MODIS (530 overpasses of SGP)

Initial results are encouraging with some issues that need examination....

Plans:

Expand to Terra MODIS and CERES MODIS ASAP (submit paper)

Expand to other ARM sites and keep up with calendar

Add additional features to examine issues – multi layer, phase, etc...